Space Weather Technical Forecast

Issued on Wednesday, 31 August 2022 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate, with three M-class flares, all from AR3088 now on the far-side. This included a long period flare that peaked M2.1 30/1929 UTC on the Earth-side, with associated far-sided halo CME, that was likely a much stronger flare on the far-side There are two Earth-sided sunspot regions, with AR3089 Ekc/Beta-Gamma-Delta the most prominent. This is a large but currently stable region that has recently traversed into the southwest quadrant. Despite the presence of a persistent delta spot, current magnetic looping appears aligned with little sign of twist or shear, however the region is still showing some slow growth. A filament eruption occurred around 30/1500 UTC, to the south of AR3089, and produced a CME that has the potential for an Earth-directed component, however analysis is still ongoing.

Solar Wind / Geomagnetic Activity: Earth is likely moving through an elongated CIR region from CH17/-, which has also picked up the turbulent sheath of the recent CME that gave a glancing impact to the Earth at 29/0245 UTC. Through the 30th this resulted in turbulent solar winds at Earth, with speeds mainly around 550 km/s, but a brief enhancement to 600-650km/s around 30/1855 UTC. Density was at or near average. The total Interplanetary Magnetic Field (IMF) strength Bt, was initially Weak to Moderate at 5-11nT, but rose to just below 15nT at 30/1855 UTC. However the north-south component was mainly positive (northward) peaking 11nT, with brief periods of negative, strongest 30/0000-0400 UTC at -8nT and again 30/1845-1900 UTC at -7nT. Phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp1-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES-16 has been below the S1/Minor Radiation storm level and has fallen towards background. The high energy electron flux (greater than 2 MeV) remained at background levels. The 24-hour integrated electron fluence remained below the Active threshold (1e8 integrated pfu) with 1.48e6 integrated pfu observed at 31/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to fall to Low with any further M-flares from AR3088 from over the limb increasingly unlikely to be observed. There is chance, however, of isolated M-flares from AR3089 in the southern centre disc, with a slight chance of X-flares.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs, however the filament eruption from the south-centre disc on the 30th is still under analysis, with the potential for a glancing impact later in the period. Any ongoing influence from the recent CME arrival (on the 29th) is expected to ease early on the 31st, with more typical coronal fast wind conditions following from CH17/-. These gradually easing through the period. There is a chance of the fast wind of CH20/+ arriving late day 4 (3rd), however this is currently expected early day 5 (4th). Quiet to Unsettled geomagnetic activity is forecast with Active intervals possible at first. Easing to Quiet with a chance of Unsettled intervals by day 2 (1st). There is a chance of this increasing to Active to G1/Minor storm intervals, with either an early fast wind arrival towards the end of day

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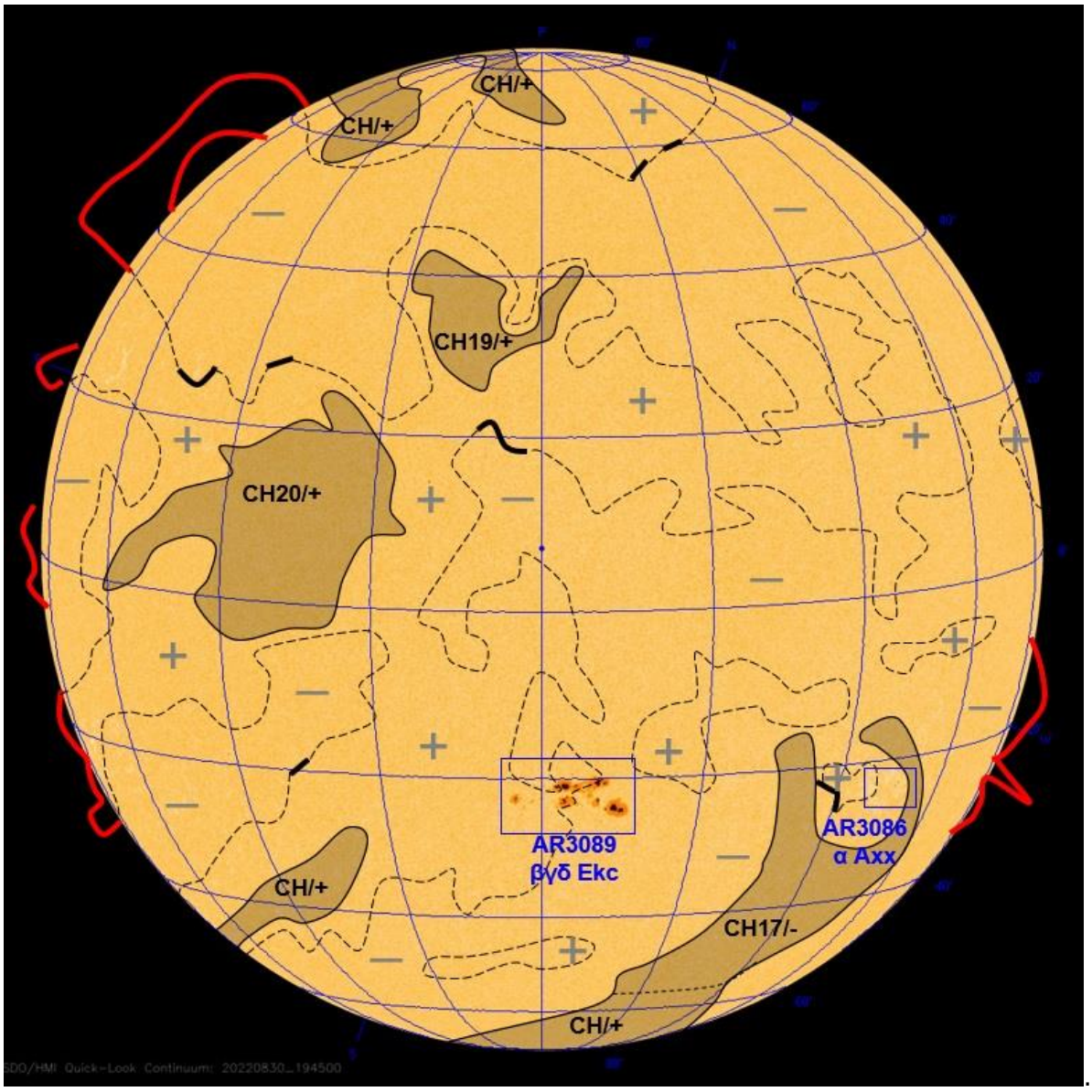
4 (3rd), or any impact that may occur from the filament eruption CME.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below the S1/Minor radiation storm levels, but with a chance of rising early day 1 (31st) due to the recent long period M2 flare from AR3088 on the far-side, and any subsequent activity. AR3089 will also provide a slight chance through the period. The high energy (greater than 2 MeV) electron flux forecast is expected to remain mostly at background, but perhaps rising to moderate with a slight chance of peaking at high, as current fast winds ease. The associated 24 hour fluence is expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs that have been analysed. A filament was observed erupting to the south and east of the disc, however, with a subsequent CME clearly visible. We are still awaiting the results of this analysis, however a glancing impact is possible from that location. All other CMEs, including the large halo, were far-sided and will not impact the Earth.

Solar winds are currently elevated to strong as Earth continues to move through the turbulent sheath of the CME from the 29th, which is now considered to have still been influencing the observed winds on the 30th. This was likely due to the CME being caught up in the CIR region around CH17/-, which Earth has also been traversing the northern edge of. A more definitive transition into the fast winds of this region is now expected day 1 (31st), as indicated by enlil.

Following this, solar winds are expected to follow the 27-day persistence until at least the 3rd. Persistence then suggests the arrival of the fast winds of the next coronal hole, CH20/+. This feature is further west on this rotation, however, with enhancement most likely to occur early on day 5 (4th), just beyond this period, but with a chance of occurring late day 4 (3rd).

Geomagnetic activity is forecast to be Quiet to Unsettled with Active intervals possible at first, but declining to Mostly Quiet with a chance of Unsettled intervals day 2 onward. There is a chance of this increasing to Active to G1/Minor storm intervals, with either an early fast wind arrival towards the end of day 4 (3rd), or any impact that may occur from the filament eruption CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: Solar Wind Persistence Model

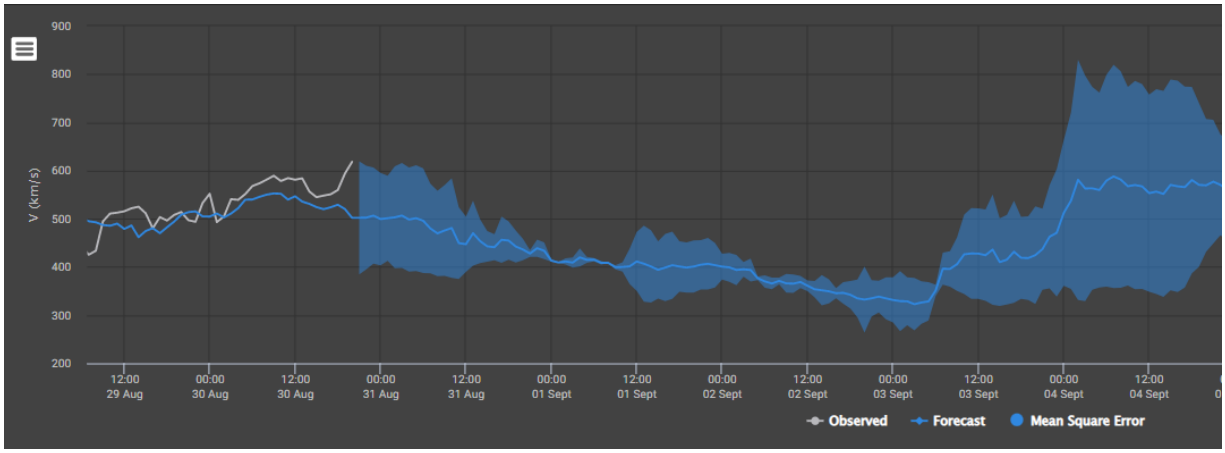

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Figure 2b: Current Enlil and Ensemble, showing current persistent CME influence and peripheral CIR from CH17/ (CME from 30th is still under analysis)

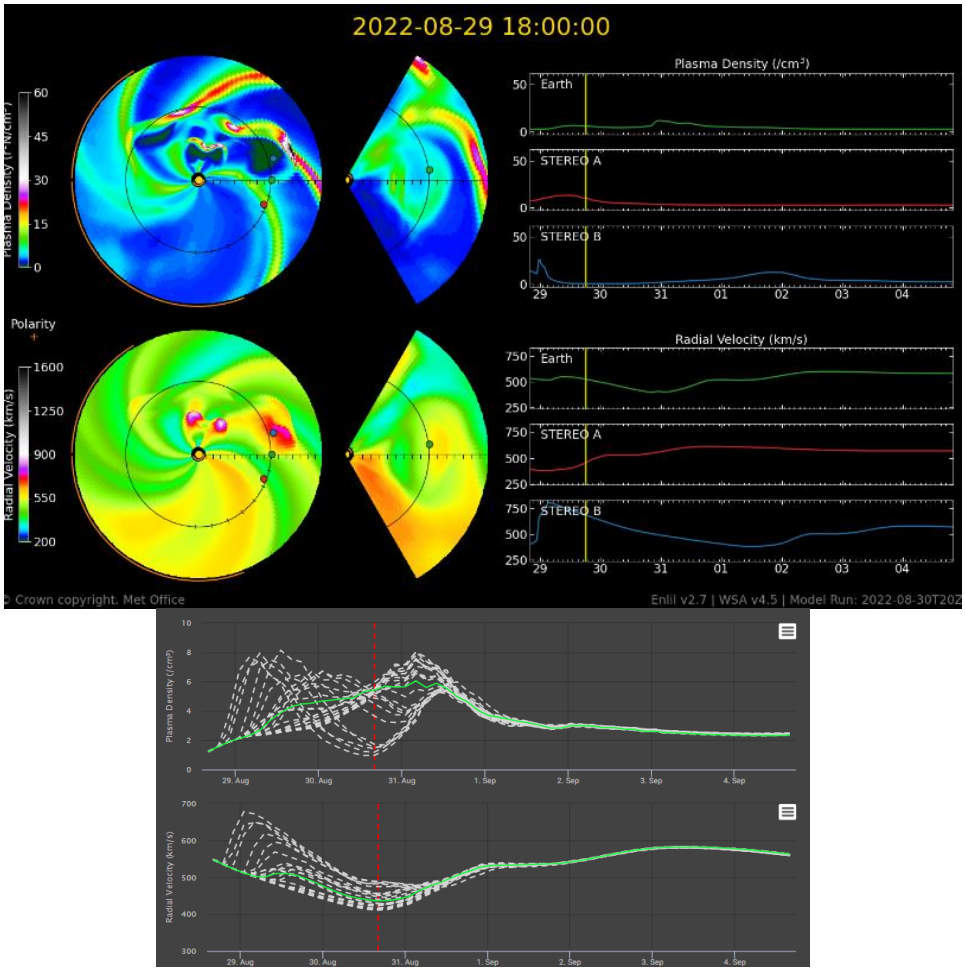
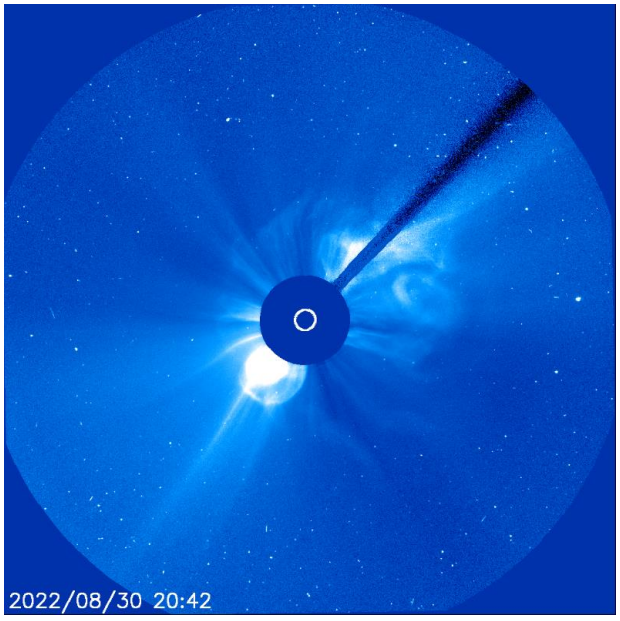


Figure 2c: CME on SOHO cor3 (to SE), with large far-side halo also visible



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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with further M-flares observed from AR3088. Despite having rotated across the southwest limb early on the 29th. After the recent large flare, which despite its far-sided location peaked M2.1 at 30/1929 UTC on the Earth-side, the visible looping of this spot appears to have diminished, with further significant flares from this region being visible now increasingly unlikely.

On the visible disc, the most prominent feature is AR3089 in the south centre region. This is classified as an Ekc/Beta-Gamma-Delta and despite the magnetic arrangement, the looping appears to be organised, with no twisting or other complexities which would suggest any instability or heightened flare risk. This region gives a chance of M-class flares and a slight chance of X-class flaring.

There are also indications on far-side products of a further region rotating on the west limb on the 1st (day 2), which may also increase flare probabilities.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	25	25	25	25
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3a: GOES 16-17 X-ray Flux

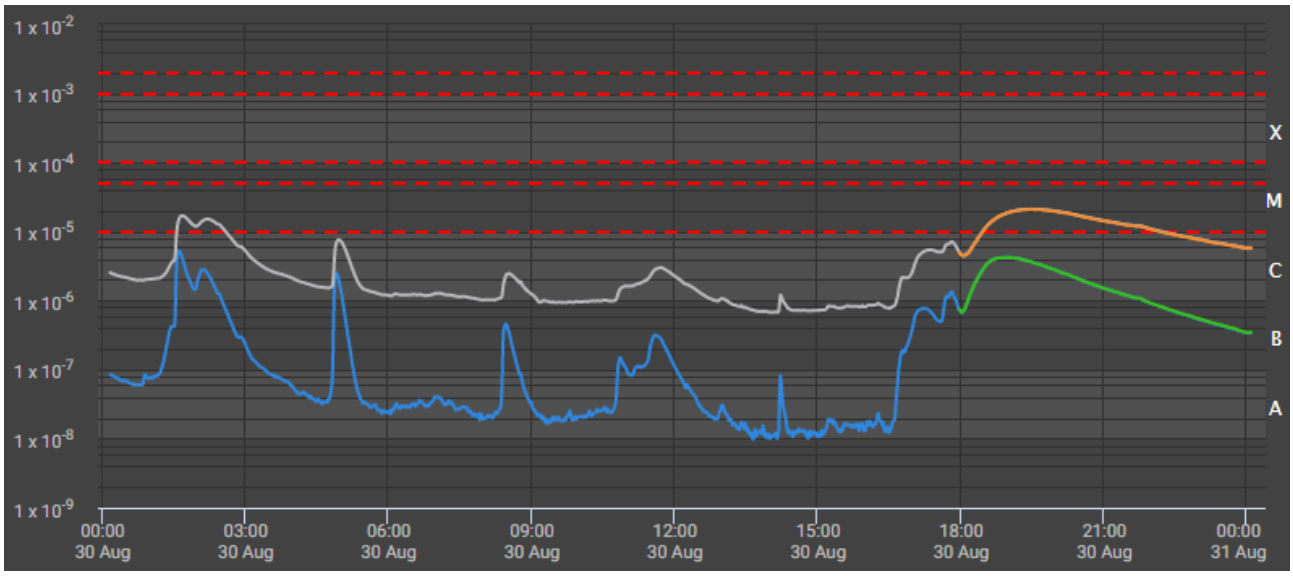

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Figure 3b: SDO hmi-intensitygram (top) and magnetogram (bottom) of AR3089

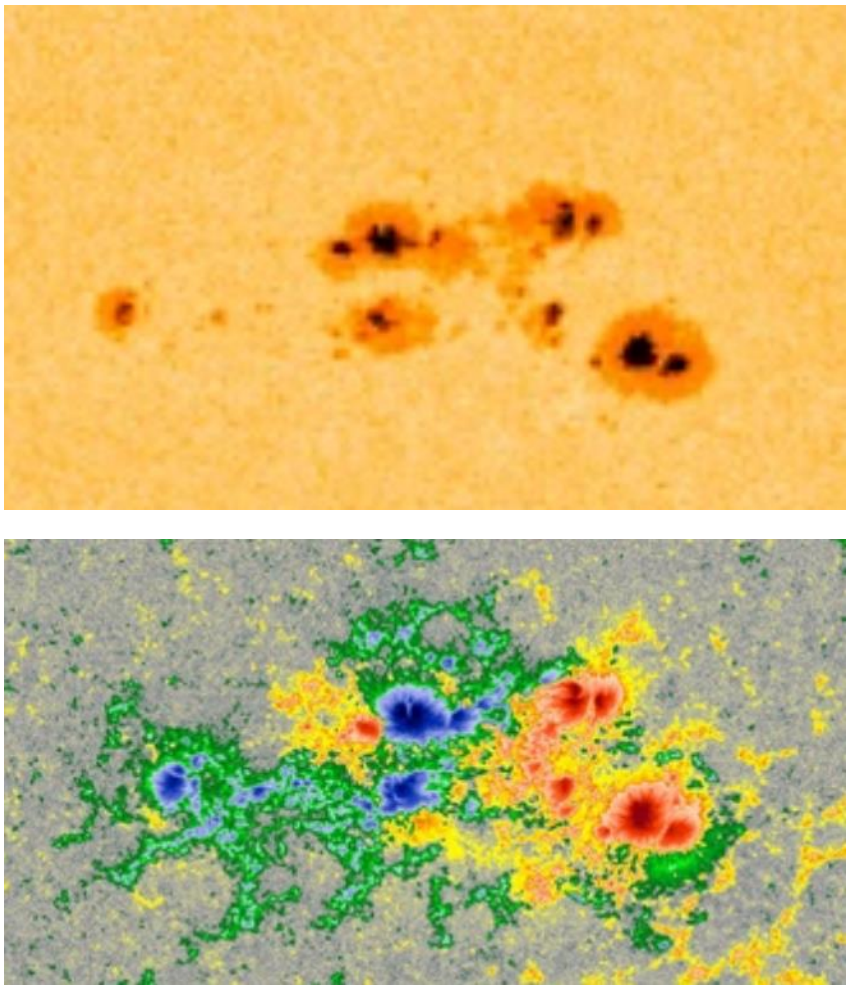
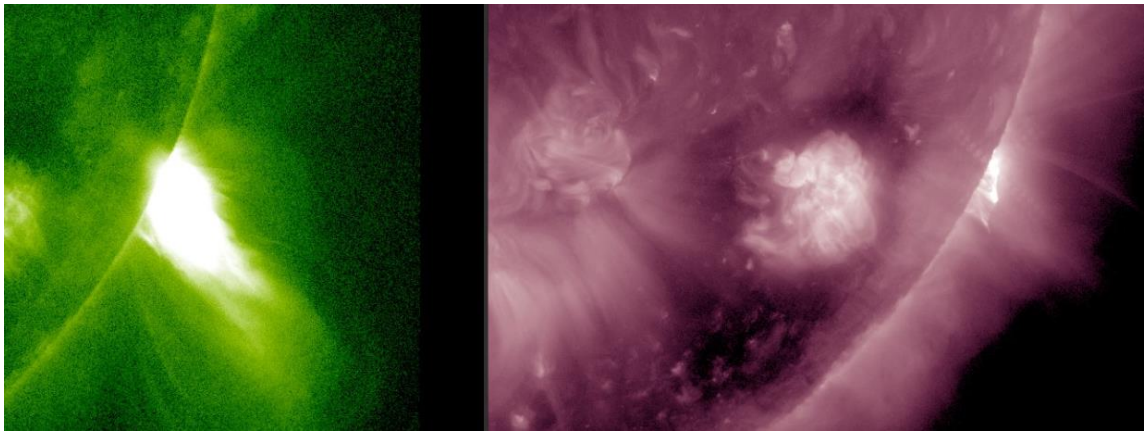


Figure 3c: SDO aia-94 and aia-171 showing large M2 flare from AR3088 around limb



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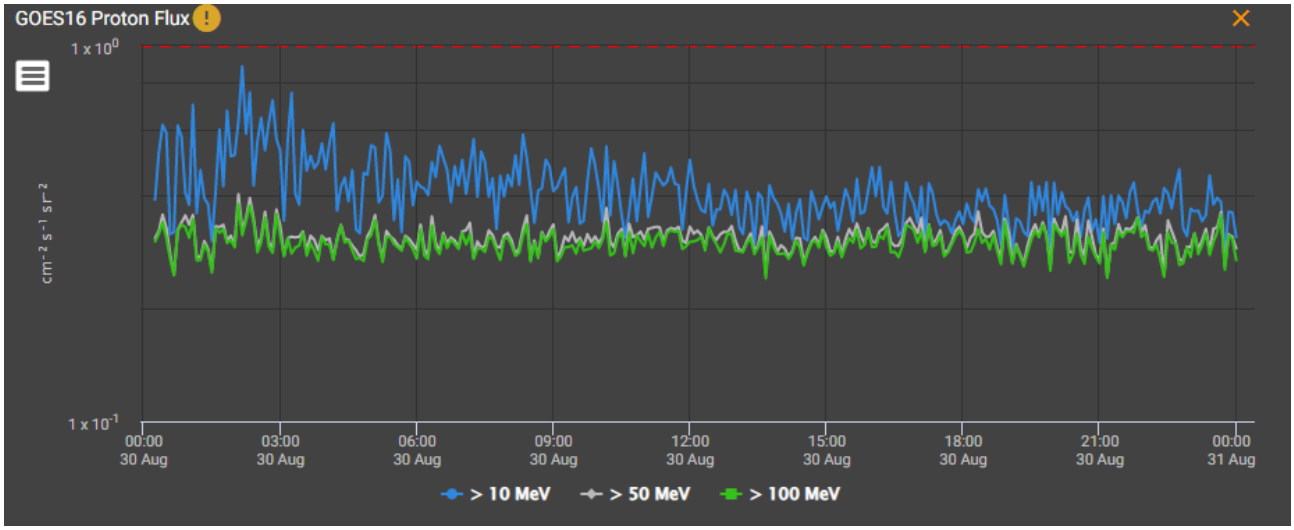
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) is now at background values after recent enhancements. The continued influence of ex-AR3089 has led to a slight chance of the S1 level being reached day 1 (31st), particularly after the large long period M2 flare, which was likely much stronger on the far-side, with a significant far-sided halo CME observed.

AR3089 (Ekc/Beta-Gamma-Delta) despite apparent stability, continues to present a slight chance of proton-rich flares should there be any significant flaring. This risk will continue as the region rotates across the southwestern quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 >10 MeV, >50MeV, >100MeV Proton Flux



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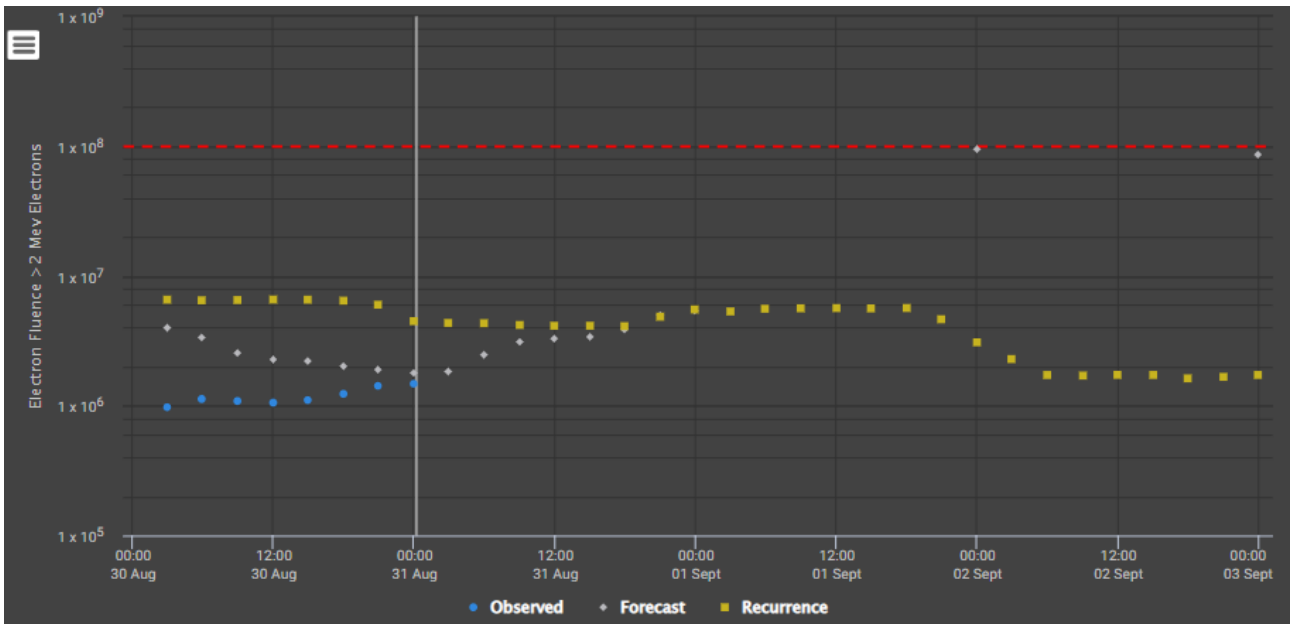
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as measured by GOES-16, is expected to remain at background values through much of the period, but potentially increasing to moderate or brief high values on diurnal peaks, with an increasing likelihood as the period progresses.
The associated electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold throughout. REFM is currently giving a good guidance, with values rising, but staying below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Fluence with REFM and Persistence.



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